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Continued Operations Risk Evaluation (Phase 0) for DOE Installations Operated by Martin Marietta Energy Systems, Inc.

The attached report summarizes the results of the Phase 0 Continued Operations Evaluation completed in December 1989. The reason for publishing this report is to provide a single document which can be referenced. On numerous occasions since the Phase 0 Evaluation was completed, a need has existed to reference the results. The individual Phase 0 Reports were not in a form that could be referenced.

This report was prepared with the assistance of Tenera.

Please refer any comments or questions to the Conduct of Operations Management Issue Team (4-8084).

D. D. Cannon, K-1310B, MS-7228 (4-6403)

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Attachment

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May 2, 1990

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OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Continued Operations Risk Evaluation (Phase 0) for DOE Installations Operated by Martin Marietta Energy Systems, Inc.

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May 2, 1990

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
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U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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EXECUTIVE SUMMARY

Because of concerns that surfaced in late 1989 as a result of appraisals of various operations of Martin Marietta Energy Systems, Inc., the Department of Energy (DOE) requested that Energy Systems provide written justification, by facility, identifying factors that would support continued operation. To provide answers to this request, Energy Systems conducted a continued operations evaluation program (Phase 0) to evaluate the risk of operating facilities involving hazards of moderate to high category. The program commenced in early November 1989 and was completed by December 31, 1989.

The objectives of Phase 0 of the continued operations evaluation program were: 1) to provide the basis for whether a facility can be operated safely, 2) to serve as interim justification for a facility to operate until more detailed analyses can be prepared, 3) to identify corrective or compensatory actions that can be taken to reduce the level of unacceptable risk, and 4) to identify any operations that should be suspended until unacceptable risks can be reduced.

Each installation appointed a Plant Safety Evaluation Team (PSET), which was responsible for selecting facilities to be assessed and for guiding and approving the risk evaluation work at the installation. A Facility Safety Evaluation Team (FSET) was selected for each facility to be evaluated. The evaluations considered only internal events. Hazards to which the public is normally exposed and standard industrial hazards were not included.

Guidelines specified by the Conduct of Operations Management Issue Team was used by the FSETs to evaluate the facilities. The FSETs identified hazards, developed scenarios, and evaluated the scenarios in terms of three elements of risk: likelihood, consequence, and mitigation. Unfavorable evaluations for all three elements resulted in the scenario being evaluated a Class A risk; unfavorable evaluations for two of the three elements, Class B; and unfavorable results for one or none of the elements, Class C. Operations with a risk classification of "A" required either immediate improvement or suspension of operation. Operations with a classification of "B" were to be considered for improvement, either immediately or in the future. Improvements were not required for operations in Class C.

The FSETs produced reports on the facilities; the PSETs produced summary reports for the installations.

A total of 538 scenarios in 48 separate facilities or integrated systems was evaluated by the five installations, with the following results:

	Number of Scenarios			
Plant	Class A	Class B	Class C	Total
Paducah	0	14	21	35
Portsmouth	0	14	34	48
Y-12	1	111	168	280
K-25	0	1	2	3
ORNL	2	32	138	172
Total	3	172	363	538

Concerning facilities with Class A scenarios, actions were taken immediately to suspend operations and/or reduce the risk to an acceptable level (Class B or less).

The results of the Phase 0 continued operations evaluations will be used in the future program and efforts of Energy Systems. All Class B and C scenarios are being further evaluated to investigate the opportunity for improvements.

1. INTRODUCTION

Because of concerns that surfaced in late 1989 as a result of appraisals of various operations of the installations of the Department of Energy (DOE) that are operated by Martin Marietta Energy Systems, Inc., DOE requested that Energy Systems provide written justification, by facility, identifying factors that would support continued operation. To provide answers to this request, Energy Systems conducted a continued operations evaluation program (Phase 0) to evaluate the risk of operating facilities involving moderate or high hazards. The program commenced in early November 1989 and was completed by December 31, 1989.

1.1. OBJECTIVE OF THE PHASE 0 PROGRAM

The objectives of Phase 0 of the continued operations evaluation program were: 1) to provide the basis for a facility to continue safe operation, 2) to serve as interim justification for a facility to operate until more detailed analyses can be prepared, 3) to identify corrective or compensatory actions that can be taken to reduce unacceptable levels of risk, and 4) to identify any operations that should be suspended until unacceptable risks can be reduced.

1.2. SCOPE OF THE PHASE 0 PROGRAM

The intent of the Phase 0 program was to evaluate all facilities that could be identified as high or moderate hazard facilities as defined by DOE Order 5481.1B. Priority consideration was given to facilities that either utilize or store acutely hazardous material, although events with potential for high energy release were a major part of the effort. Hazards to which the public is normally exposed and standard industrial hazards were excluded from the scope of the program. Only internal events were included; that is, external events such as earthquakes and tornadoes were not considered in the Phase 0 analyses.

All facilities and integrated systems at the five major installations of DOE operated by Energy Systems were initially potential candidates for examination by the Phase 0 program. From a practical standpoint, it was known that the facilities that should be examined were those previously identified as needing an updated safety analysis report. In deciding whether a facility was to be included in the Phase 0 evaluations, the Plant Safety Evaluation Teams (PSETs) considered a number of factors, such as the type of hazards present, the operational status of the facility, and whether there was a special ongoing program to determine safety of operation (such as for the High Flux Isotope Reactor). Generally, nonoperating facilities were excluded from the Phase 0 program. Facilities with special ongoing safety determination programs were also excluded.

1.3. PROCEDURE FOR IMPLEMENTATION OF THE PHASE 0 PROGRAM

Each installation appointed a PSET, which was responsible for selecting facilities to be assessed and for guiding and approving the risk evaluations at the installation. A Facility Safety Evaluation Team (FSET) was selected for each facility to be evaluated. Guidelines specified by the Conduct of Operations Management Issue Team were used by the FSETs to evaluate the facilities. The FSETs identified hazards, developed scenarios, and evaluated the scenarios in terms of three elements of risk: likelihood, consequence, and mitigation. The risks of each facility were classified as to acceptability, and actions taken as necessary to reduce risk. The FSETs produced reports on the facilities; the PSETs produced summary reports for the installations.

1.4. OBJECTIVE OF THIS REPORT

The objective of this report is to summarize for Energy Systems and DOE the results of the Phase 0 continued operations evaluation program. The Phase 0 program resulted in a favorable disposition for all facilities examined; facilities identified as high risk were either shut down or their risk was reduced immediately. This report is to serve as a basis for confidence to move forward with operations, considering that more detailed analyses will be conducted for moderate risk facilities. The report also serves as a basis for summarizing the areas where improvements might be made to reduce risk.

2. METHODOLOGY

Guidelines were prepared by the Conduct of Operations Management Issue Team to establish a consistent method and approach for organizing and performing the assessment of the basis for continued operations at the five installations operated by Energy Systems for DOE. All five sites chose to employ those guidelines; thus one general discussion of the methodology will suffice. There were two important aspects of the methodology: 1) the establishment of a suitable organizational system to carry out the work and 2) the establishment of acceptable methodology for the organizational system to use successfully on a large number of facilities in a short period of time.

2.1. ORGANIZATIONAL SYSTEM FOR PHASE 0 PROGRAM

Each Plant or Installation Manager appointed a PSET to select the facilities to be assessed and to direct and approve the work done in Phase 0. Each PSET was led by a senior manager with significant operations experience. The PSETs were balanced in membership by having members that represented different perspectives and insight such as from safety and oversight groups. In two instances DOE managers served on the PSET. The installations appointed an FSET to evaluate each facility selected by the PSET for evaluation. To make the evaluations of the FSETs most relevant and obtain a sense of ownership by the operating organizations, it was suggested that the FSETs be headed by a member of the operating organization (preferably from the facility organization). The FSETs were also balanced in their membership. There were variations in the detail of applying these organizational principles, but, in general, the principle of using multi-disciplinary teams was universally applied.

2.2. RISK ASSESSMENT METHODOLOGY

Definition of the nature and extent of the risks of continued operation of the various facilities required that there be produced for each facility or system a risk information base. This information base identified sources of hazards and then categorized the risk for the hazard based on relative rankings for potential initiating events or release pathways; the consequences of the hazard to workers or to the public if unmitigated; and the design and operational features present to prevent or reduce the likelihood of, or mitigate the consequences of such events. Figure 2.1 illustrates the evaluation process used to produce this risk information base. Following are details for the individual steps in the process.

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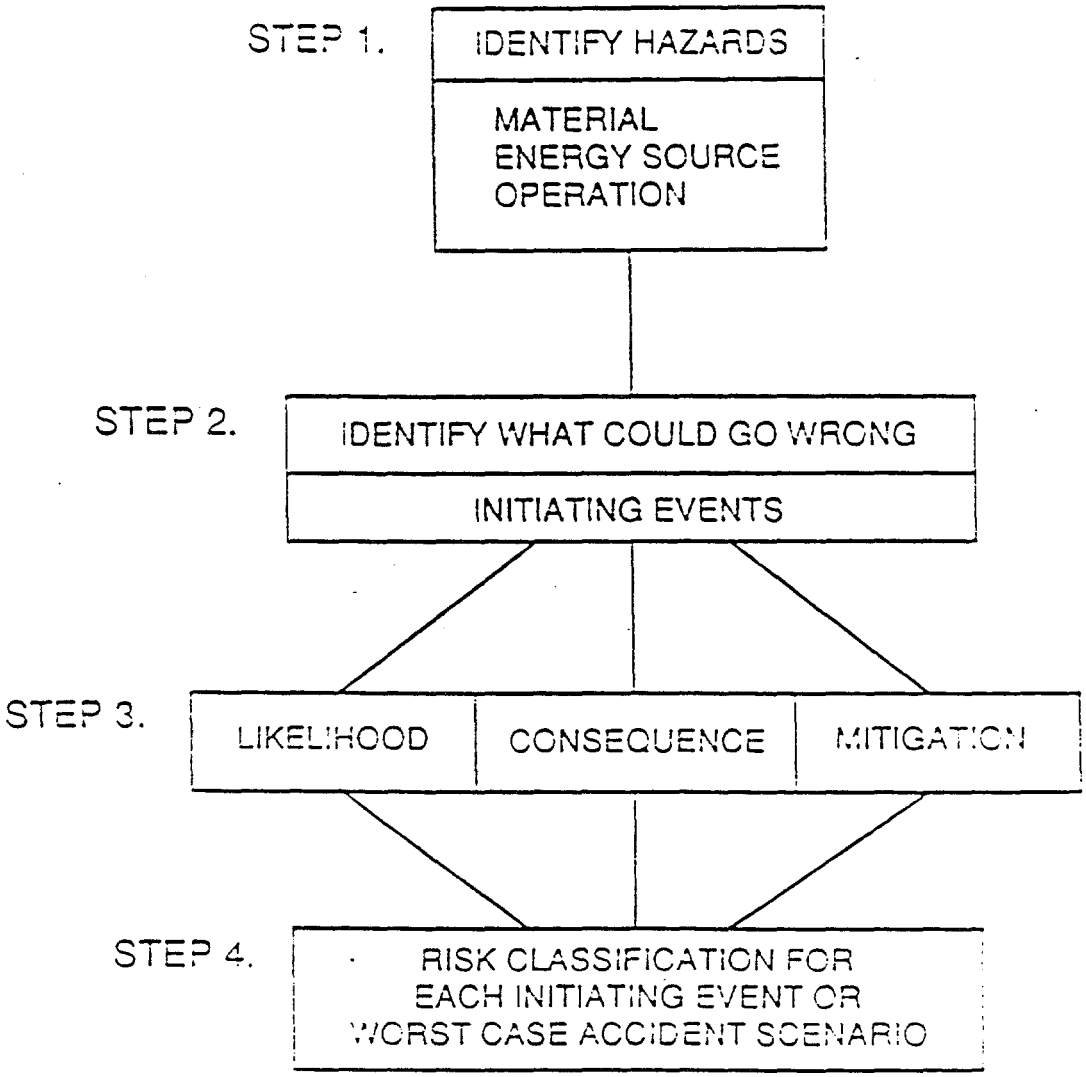

Fig. 2.1. Risk Evaluation Process

2.2.1 Step 1 - Hazard Identification

Hazards were defined based on the definition from DOE Draft Order 5481.C:

HAZARD: A material, energy source, or operation that has potential for causing injury or illness in humans and/or damage to a facility or the environment without regard for the likelihood or credibility of accident scenarios.

The first step in the evaluation process was to define hazards for the facility (or plant in the case of the Gaseous Diffusion Plants) based on the above definition, focusing on those hazards that could result in significant health and safety impacts either on-site or off-site. Hazards from process and nonprocess chemicals were defined for the entire facility, based on the location in the plant where the material was stored or utilized or where the operation takes place. Hazards from energy sources derived from radiological hazards or fires/explosions resulting from exothermic reactions. Operational hazards derived from operations required at the facility.

2.2.2 Step 2 - Initiating Events Identification

The next step in the evaluation process was to identify and scope accident scenarios based on initiating events, such as equipment failures, that could occur during normal operation, process upsets, or accident conditions. With respect to each hazard identified in Step 1, the question was asked, **"What could go wrong?"** Experience based on precursor events that have occurred at this facility or similar facilities was considered.

2.2.3 Step 3 - Evaluation of Likelihood, Consequence, and Mitigation for Each Event

For each initiating event from Step 2, the FSET conducted an evaluation and ranking as to the likelihood of the event occurring, including preventive measures/systems, potential consequences to workers or the public if unmitigated, and mitigative features that were provided to reduce the consequence of the event.

1) Likelihood

The likelihood of occurrence of the accident/initiating event was ranked as "1" for low likelihood and "2" for high likelihood. A score of "2" implies significant potential for the event to occur during the next ten years. Although not all inclusive, attributes denoting high likelihood include: (1) the event has occurred at the plant before and no changes have been made to prevent the initiator; (2) the event has occurred at similar plants or in similar processes and there are no preventive measures in place at this plant; (3) there is high probability of equipment failure, and operators do not have training or procedures to respond to such a failure; (4) passive failure modes exist where there are no reliable procedures for inspection or testing to determine (or confirm) that the

component is safely operable; or (5) a phenomenon or event that has caused an event in the past is not resolved or understood, yet conditions might still exist to cause a similar event at this facility.

Attributes denoting low likelihood include: (1) passive failure modes such as pressure vessel rupture, piping leaks, and corrosion of UF_6 cylinders, where plant records and generic data indicate a low probability of occurrence; (2) operator-related events for which operators have good training, procedures, and operational experience; (3) cases where there were previous precursors or initiators but modifications of equipment or procedures have been made to prevent recurrence; (4) events that are prevented by redundant control systems or require multiple failures before the hazard will occur; or (5) events that have not occurred at this plant or at similar facilities.

2) Potential Consequences

Potential consequences for accidents (or events) were ranked as "1" for low potential of the event or accident to have serious impact on the health and safety of the public or the site workers. Significant or high potential of the event to have serious impact on the health and safety of the public or workers is ranked as "2." These consequence rankings are based on the unmitigated effects of the hazards. Attributes denoting high-consequence events involve releases of significant amounts of radiological materials, unique toxic chemicals, or high-level energy in the proximity of workers or the public. Attributes denoting low-consequence events include: release of insignificant amounts of hazardous materials such that radiological/toxic limits for on-site personnel and site boundaries would not be exceeded, release conditions where serious exposure is unlikely due to limited access or length of exposure to the hazard, or low-level energy release from the hazard to workers.

3) Mitigation

Effective mitigation measures that can significantly reduce the consequences associated with the hazards were ranked as "1." Ineffective or lack of mitigation was ranked as "2." Attributes associated with effective mitigation include: (1) the availability of active systems that are designed to isolate or contain releases or limit propagation of the hazard and are regularly tested, inspected and maintained: (2) the ability of personnel or instrumentation to promptly detect the event through monitoring and alarm systems and to limit event severity; (3) the existence of natural barriers to prevent or limit exposure to site workers or the public; and (4) adequate procedures for operator response to the event with evidence that operator training, drills, and emergency exercises are in effect. Attributes associated with ineffective mitigation include: (1) lack of one or more of the above measures for effective mitigation or (2) accident conditions that may result in explosions, fires, or other highly exothermic reactions that could defeat/disable the mitigative or containment/confinement systems.

2.2.4 Step 4 - Risk Classification

For every location in the plant or facility where a particular hazard could occur, the initiating events were evaluated, as discussed in Step 3, to determine the hazard likelihood, consequence, and mitigation rankings. The risk from the occurrence of a specific hazard was classified using the risk matrix of Table 2.1 based on the rankings for likelihood, consequence, and mitigation relating to that particular initiating event. In most cases, it was possible to define a worst-case accident scenario for a hazard in a particular location where the risk from that accident scenario bounded consideration of a similar hazard in other locations in the facility or plant.

Table 2.1. Risk Matrix

Likelihood	Potential Consequence	Mitigation	Risk Class
2	2	2	A
2	1	2	B
2	2	1	B
2	1	1	C
1	2	2	B
1	1	2	C
1	2	1	C
1	1	1	C

The implications of the relative risk class rankings to the disposition or actions to be taken with respect to the hazard being evaluated are as follows:

Class A Risk - Serious risks to workers and/or public were identified that require immediate resolution or suspension of operations associated with that hazard.

Class B Risk - No serious risks were identified, but opportunities for effective risk reduction or safety enhancement exist that should be evaluated in subsequent studies; continue plant operations.

Class C Risk - No serious risks were identified, but the information should be preserved for possible improvement actions; continue plant operations.

2.3 RESULTS OF CONTINUED OPERATIONS EVALUATIONS AT EACH INSTALLATION

Each of the five major installations conducted the continued operations evaluation in the November-December 1989 time frame. Each installation produced a report detailing the results. The following sections summarize the results for each installation.

3. K-25 CONTINUED OPERATIONS EVALUATION

3.1 IMPLEMENTATION OF METHODOLOGY AT K-25

Because of the relatively low hazards associated with operation of the K-25 Site, there should be few facilities of concern as operational risks. However, the approach taken at K-25 has been to look closely at a number of operations to ensure that the staff has thoroughly considered the hazards associated with these operations, the mitigating circumstances that we have put in place, and the risks associated with the continued operation of the different facilities at K-25.

The facility safety evaluation conducted of the K-25 Site identified the Radiation Alarm System for further study for methods of risk reduction. Several other operations and facilities were examined in the Phase 0 evaluation including those that were known to contain only standard industrial hazards.

These reviews included the Toxic Substances Control Act (TSCA) Incinerator, Central Printing, Natural Gas Distribution, the Sanitary Water facilities, the Sewage Treatment facilities, the Recirculating Cooling Water Systems, Advanced Laser Isotope Separation Operations, the Shutdown gaseous diffusion facilities, the Waste Management Operations facilities, the applied technology facilities, and the Analytical Laboratories. These facilities are not discussed in this report because they did not meet the criteria for selection given in Section 1.2.

The PSET was composed of the K-25 Plant Manager and the K-25 Site Contractor Officer Representative. Facility Safety Evaluation teams consisted of line managers and Environmental Health and Safety staff members at K-25.

3.2 RESULTS OF K-25 EVALUATIONS[1]

No risks to the public or to plant workers that would cause suspension of operations were identified in this evaluation, but there were some risks identified that need to be evaluated in more detail to determine effective ways to reduce their associated risk.

A thorough analysis of the hazards associated with the Radiation Alarm System was performed. The evaluation pointed out that alarms should be reactivated in the K-31 and K-33 Buildings at the K-25 Site to cover areas not covered when the diffusion plant facilities were shut down in 1985. Several actions have been taken recently to ensure proper criticality detection at the site; however, all detectors still need to be upgraded, the annunciators need to be upgraded, the public address (PA) system needs to be upgraded, and the fissile storage areas need to be evaluated continuously to determine what, if any, improvements are necessary in these areas.

Results of the K-25 evaluation in terms of risk classification of scenarios are given in Table 3.1.

Table 3.1. Results of K-25 Evaluation by Risk Classification

Facility or System	Number of Scenarios			
	Class A	Class B	Class C	Total
Radiation Alarm		1	2	3

4. OAK RIDGE NATIONAL LABORATORY CONTINUED OPERATIONS EVALUATION

4.1 IMPLEMENTATION OF METHODOLOGY AT ORNL

A PSET was appointed by the Oak Ridge National Laboratory (ORNL). Members represented safety oversight organizations, quality assurance, and operating organizations. The Department of Energy was represented at meetings of the PSET.

Facility Safety Evaluation Teams were appointed for twenty facilities and systems.

The PSET reviewed the results of FSET evaluations. Criteria that guided PSET actions during the reviews included the following:

1. If a subject analysis was not documented, the analysis was considered not to exist.

2. Single mode failures were emphasized.

3. If the return of an accident was greater than one in ten years, then the likelihood was scored "2." However, a conservative approach was used; and it is more accurate to say that, if the likelihood was in the range of 10^{-6}, per year, it was scored as "1."

4. For the consequence determination, if an operator could receive a postulated dose of one rem, then the consequence was scored "2."

Final results of the ORNL evaluations were reviewed in a meeting of DOE managers, ORNL managers, PSET and the evaluation staff on December 18, 1989.

4.2 RESULTS OF ORNL EVALUATIONS[2]

The following are the recommendations of the PSET taken from their summary report.

1. Develop a laboratory policy which will establish effective, documented limits on quantities of hazardous materials allowed in facilities, hot cells, glove boxes, and hoods.

2. Establish facility managers at multi-division buildings/facilities who have accountability, authority, and documented controls over facility activities including those of other building/facility tenants.

3. Eliminate facilities with no current or planned operations and inventory from the subsequent safety analysis program.

4. The subsequent safety analysis program (Phase 1) should carefully prioritize Laboratory facilities for external events analysis (seismic, tornado, flood, and fire). Consideration should be given to facilities that have been previously analyzed.

5. The subsequent safety analysis program (Phase 1) should include more detailed analysis of glove box, hood, and hot cell fires, explosions, and implosions.

6. The safety documentation upgrade process should establish auditable controls on SAR requirements with clear flow down to operating safety requirements, procedures, and training.

The evaluations at ORNL produced two Class A risk scenarios for which "24-hour" fixes were implemented. For Building 3019, within 24 hours, administrative controls were established to limit the amounts of flammable materials permitted in glove boxes. For Building 7855, within 24 hours, administrative controls were established to prohibit movement of concrete waste casks currently stored in Building 7855. The PSET also ordered additional analyses of: 1) the safety of moving the concrete waste casks in Building 7855 and 2) the survivability of plastic containers used inside Building 7920 concrete waste casks for transuranium waste and the credible dose should the cask fail if it were dropped. One of the DOE participants also requested that ORNL clarify the current and future use of Building 3019 in the context of the standby status of its U-233 processes.

Results of the evaluations at ORNL in terms of classification of risk of scenarios are given in Table 4.1

Table 4.1. Results of ORNL Evaluation by Risk Classification

Facility or System	Number of Scenarios Class A	Class B	Class C	Total
Chemical Separations Laboratory (Bldg. 3026-C)		1	5	6
Central SNM Storage Vault (Bldg. 3027)				None
Irradiated Materials Examination and testing Facility (Bldg. 3025E)			3	3
Radioisotope Production Lab A (Bldg. 3028)				None
Source Development Laboratory (Bldg. 3029)		1	4	5
Liquid Low-Level Waste System			4	4
Actinide Fabrication Laboratory (Bldg. 3033 Annex)		2	4	6
Krypton and Tritium Facility (Bldg. 3033)		1	6	7
Fission Product Development Laboratory (Bldg. 3517)		1	7	8
High-Level Radiochemical Laboratory (Bldg. 4501)		2	8	10
High-Radiation-Level Examination Laboratory (Bldg. 3525)		2	12	14
Radioisotope Development Laboratory (Bldg. 3047)		4	9	13
Transuranium Research Laboratory (Bldg. 5505)		1	5	6
Radioisotope Development Laboratories (Bldgs. 3030/3118/ 3031)		1	5	6
Radioisotope Packing and Shipping Facility (Bldg. 3038)		8	24	32
Radiochemical Development Facility (Bldg. 3019)	1	3	11	15
Shielded Drywell Facilities (Bldgs. 7827/7829)			2	2
Concrete Retrievable Storage (Bldg. 7855)	1		1	2
Radiochemical Engineering Development Center (Bldg. 7920)		4	7	11
Radiochemical Engineering		1	21	22
TOTAL	2	32	138	172

5. PADUCAH GASEOUS DIFFUSION PLANT CONTINUED OPERATIONS EVALUATION

5.1 IMPLEMENTATION OF METHODOLOGY AT THE PADUCAH GASEOUS DIFFUSION PLANT (PAD)

The risk evaluation methodology was applied to PAD during November 14-16, 1989. After a brief orientation session, the hazard identification portion of the risk evaluation was conducted. The orientation session was attended by the PAD plant manager; division managers from Operations, Maintenance, and Plant and Personnel Protection; managers from Engineering, Technical Services, and Facility Safety; a site DOE representative; the Portsmouth Gaseous Diffusion Plant Quality and Technical Services Manager; and a variety of technical experts in the various process-related fields. Personnel from Energy Systems in Oak Ridge, H&R Technical Associates and TENERA served to facilitate the evaluation process and to promote consistency in interpreting and applying the methodology. The PAD division managers from Operations and Plant and Personnel Protection; senior managers from Engineering, Maintenance, Technical Services, and Facility Safety; and the process facilitators comprised the PSET which selected the hazards and process facilities to be analyzed.

To expedite the evaluation process, this larger body of PAD personnel was broken up into FSETs of four to five persons, each with a PAD manager to serve as team leader and a process facilitator to conduct the likelihood, consequence, and mitigation evaluations leading to risk classification rankings for all identified hazards. Teams were comprised of individuals from Operations, Maintenance, Facility Safety, and various other plant divisions called in as special site expertise was required to address questions that arose during the evaluations. Over 50 plant personnel were involved in the entire exercise. The recommendations from the risk evaluations were reported to the assembled PSET for review, discussion and approval.

The risk evaluation for PAD was conducted only for the operating part of the plant associated with production and related technical support activities. The evaluation did not include hazard analyses relating to (1) items covered under the Remedial Action Program and Waste Management Program; (2) nonoperating facilities such as the Metals Plant or the Feed Plant; (3) standard industrial hazards addressed by Occupational Safety and Health Act (OSHA) requirements; (4) new plant processes that are not in service, such as the Process Inventory Control System, the High-Assay Upgrade Project, and the Intermediate Gas Removal System; (5) external events due to natural phenomena, such as earthquakes, floods, and tornadoes; (6) criticality events because they are considered to be adequately addressed in the existing plant Facility Safety Analysis Report (FSAR), which reflects current plant operations; and (7) transportation events outside the plant, such as vehicle accidents.

The first step in the risk evaluation process involved defining hazards for the plant based on the DOE Draft Order 5481.1C. The compilation of hazardous materials, energy sources, and operations at PAD was derived from a variety of sources, including (1) the existing PAD FSAR, (2) the PAD *Hazardous Material Review Study*, KY/L-1382, (3) *Evaluation of Potential for Incidents Having Health or Safety Impacts*, DOE/OR-860, (4) results of PAD audits/reviews, (5) results of risk/vulnerability studies, and (6) "brainstorming" based on input from PAD representatives. Four categories of hazards were identified:

1. Hazardous operations
2. Hazardous energy sources
3. Hazardous chemical releases (other than UF_6)
4. Hazardous release of UF_6

Once the entire list of hazards was compiled for each category, the hazards were screened before further evaluation. For example, hazardous events related to standard OSHA accidents; standard industrial chemical releases; and external events, such as earthquakes, were considered outside the scope of this investigation. Table 5.1 presents a lists of hazards that remained for each category after the screening process was completed.

Table 5.1. Hazards Identification

Operations Hazards	Energy Source Hazards	Chemical Hazards	UF_6 Hazards By Facility
Lube oil system	Radiation sources	Chlorine trifluoride (ClF_3)	Enrichment Facility
PCB contamination	Exothermic reactions	Fluorine (F_2)	Feed Facility
Radiation/ contamination		Freon (R-114)	Product Withdrawal Facility
			Tails Withdrawal Facility
		Hydrogen fluoride (HF)	
		Technetium	Sampling and Transfer Facility
Waste handling and sampling		Transuranics	Cylinder Storage Facility
Criticality		Uranium tetrafluoride (UF_4)	
		Other uranium compounds	

5.2 RESULTS OF PAD EVALUATIONS[3]

Evaluation of risks resulting from the remaining hazards was performed. The results of the evaluations for PAD are presented in Table 5.2 in terms of classification of risk by scenario.

Table 5.2. Results of Paducah Gaseous Diffusion Plant Evaluation by Risk Classification

Hazard Group or Facility	Number of Scenarios			
	Class A	Class B	Class C	Total
Operations		2	3	5
Energy Source			1	1
Chemical		4	4	8
UF_6 Hazards				
Cascade		2	2	4
Feed Facility			4	4
Product and Tails Withdrawal Facilities		3	2	5
Sampling and Transfer Facility		3	1	4
Cylinder Storage Facility		—	4	4
TOTAL		14	21	35

Risks evaluated for the Operations and Energy Source hazards and Chemical Hazards were generally based on the worst-case accident scenarios. Risks evaluated for UF_6 were based primarily on release of the gas during the various process steps. Initiating

events at the various process-related facilities were based on equipment failures, support or control system failures, operator errors, or fires/explosions that could result in a release of UF_6 and present a risk to either site workers or the public.

Although more initiating events were considered and ranked for the items in each category, these tables present the significant findings for the bounding events, by listing the hazard, the accident scenario or initiating event, the evaluation based on the likelihood/consequence/mitigation of that event, and the resulting risk classification ranking.

5.3 CONCLUSIONS OF THE PADUCAH GASEOUS DIFFUSION PLANT EVALUATIONS

The most important finding of the hazards analysis was that there appeared to be no Class A Risk conditions at PAD, i.e., there were no risks to workers or the public that were serious enough to require immediate resolution or suspension of the operation associated with the hazard.

There were, however, several areas in which Class B Risk conditions exist, i.e., no serious risks to workers or the public were present, but opportunities exist for further study to achieve additional risk reduction. In particular, the conditions delineated below, which have the potential for off-site as well as on-site impacts, offer opportunities as described:

- A ClF_3 release or an F_2 release from fire/explosion due to use of incompatible materials; an HF release from cylinder puncture; a PCB release due to fire in a transformer or capacitor.

  Because preventive measures are engineering specifications and procedures, examination of these controls for possible improvement and reviews of applications of specifications/procedures offer the potential for further risk reduction. Additionally, since Emergency Response is currently the most effective form of mitigation for the release of any toxic gas, further study of the training/procedures/ public notification in this area could improve overall safety.

- A UF_6 release resulting from a lube oil system fire/ventilation ducting fire in a process building.

  Opportunities for additional risk reduction in these areas may be identified in the studies currently underway by Factory Mutual and JBF Associates. Factory Mutual is assessing the plant from the perspective of a fire insurance underwriter and is evaluating the fire risk in both the lube oil system and the ventilation ducting. JBF Associates is conducting a failure analysis and risk assessment of the fire water systems.

- A UF_6 release from crane failure in a process building.

  Opportunities for improvement in this area involve examination of the relevant maintenance and operations procedures and administrative controls for ways to strengthen both preventive and mitigative measures.

- A UF_6 release from a cylinder drop and puncture in the Product Withdrawal Facility, Tails Withdrawal Facility, or Sampling/Transfer Facility.

  There are activities and studies underway aimed at improving the safety of the lifting, moving, and overall handling of cylinders. The ongoing multi-site UF_6 Cylinder Handling Committee is one such activity that makes recommendations with respect to safety improvements. Additionally, a formal probabilistic risk assessment (PRA) is being conducted for the Portsmouth Gaseous Diffusion Plant (PORTS) by SAROS, who will evaluate the risks of cylinder-handling operations. The PORTS report from SAROS was due in March 1990, after which, a similar PRA will be conducted for PAD. It is expected that areas for improvement will be identified from this work.

- A UF_6 release from explosion due to hydrocarbons in product or tails cylinders.

  Opportunities for further study in this area involve work with vendors to improve their quality assurance and eliminate sources of oil inleakage and work in-house to improve/increase inspections of cylinders.

Other Class B Risk conditions exist with the potential for on-site impact only. These hazardous conditions, which include PCB contamination, radiation exposure, and R-114 release, also offer opportunities for effective risk reduction and merit subsequent studies.

In addition, Class C Risk conditions, i.e., those which pose no serious risks but which should be incorporated into improvement planning, were identified. These include such conditions as lube oil system fires and UF_6 release due to B-line block valve closure.

The hazards analyses and resulting risk evaluations summarized above characterize the conditions that support continued operation of PAD.

6. PORTSMOUTH GASEOUS DIFFUSION PLANT CONTINUED OPERATIONS EVALUATION

6.1 IMPLEMENTATION OF METHODOLOGY AT PORTSMOUTH GASEOUS DIFFUSION PLANT (PORTS)

The risk evaluation methodology, discussed in Section 2, was applied to PORTS during November 30-December 1, 1989. After a brief orientation session, the hazard identification portion of the risk evaluation was conducted. The orientation session was attended by the PORTS Director of Site Operations (acting as Plant Manager); division managers from Production, Engineering, Quality and Technical Services, Maintenance, and Environment, Safety and Health; managers from Operations Engineering, Facility Safety, Safety Analysis, and Contamination Control; and a variety of technical experts in the process-related fields. Personnel from Energy Systems in Oak Ridge, H&R Technical Associates, and TENERA served to facilitate the process and to promote consistency in interpreting and applying the methodology. Portsmouth division managers, other senior managers, and the process facilitators comprised the PSET which selected the hazards and process facilities to be analyzed. The process used to conduct the evaluation was similar to the process used at Paducah. The limitations of the evaluations were the same as those given for Paducah in Section 5.1.

The first step in the risk evaluation process involved defining hazards for the plant based on the DOE Draft Order 5481.1C. The compilation of hazardous materials, energy sources, and operations at PORTS was derived from a variety of sources, including (1) the existing PORTS FSAR, (2) *Evaluation of Potential for Incidents Having Health or Safety Impacts*, DOE/OR-860, (3) results of PORTS audits/reviews, (4) results of risk/vulnerability studies, and (5) "brainstorming" based on input from PORTS representatives. Four categories of hazards were identified:

1. Hazardous operations
2. Hazardous energy sources
3. Hazardous chemical releases (other than UF_6)
4. Hazardous release of UF_6

Table 6.1 lists the hazards that were evaluated.

Table 6.1. Hazards Identification

Operations Hazards	Energy Source Hazards	Chemical Hazards	UF_6 Hazards By Facility
Lube oil system	Radiation sources	Chlorine trifluoride (ClF_3)	Cascade
PCB contamination	Exothermic reactions	Fluorine (F_2)	LEU Feed and Sampling Facility
		Hydrogen Fluoride (HF)	
Radiation/ contamination		Freon (R-114)	LEU and Tails Withdrawal Facility
			HEU Withdrawal Facility
Liquid nitrogen production		Technetium (^{99}Tc)	LEU Sampling and Transfer
			High Assay Sampling and Analysis Facility (HASA)
Waste handling and sampling			Large Cylinder Storage Facility
Criticality			Small Cylinder Storage Facility
Uranium recovery		Uranium oxides and other compounds	

Note: LEU = low enriched uranium where ^{235}U assay is <5%.
HEU = highly enriched uranium where ^{235}U assay is >7%.

6.2 RESULTS OF PORTSMOUTH EVALUATIONS[4]

The risks at Portsmouth were evaluated using the same methodology as that used for Paducah, which is given in Section 5.2.

The results of the Portsmouth evaluations, summarized by classification of scenarios for facility or hazard groups, are given in Table 6.2.

Table 6.2. Results of Portsmouth Gaseous Diffusion Plant Evaluation by Risk Classification

Hazard Group or Facility	Number of Scenarios			
	Class A	Class B	Class C	Total
Operations		1	5	6
Energy Source			1	1
Chemical		4	2	6
UF_6 Hazards				
Cascade		1	3	4
Feed and Sampling Facility		2	3	5
LEU/Tails Withdrawal		3	1	4
HEU Withdrawal			4	4
LEU Sampling/Transfer Facility		3	2	5
High Assay Sampling Area			4	4
Large Cylinder Storage Facility			5	5
Small Cylinder Storage Facility			4	4
Total		14	34	48

6.3 CONCLUSIONS OF THE PORTSMOUTH GASEOUS DIFFUSION PLANT EVALUATION

The most important finding of the hazards analysis was that there appeared to be no Class A Risk conditions at PORTS, i.e., there were no risks to workers or the public that were serious enough to require immediate resolution or suspension of the operation associated with the hazard.

There are, however, several areas in which Class B Risk conditions exist, i.e., no serious risks to workers or the public are present, but opportunities exist for further study to achieve additional risk reduction. In particular, the conditions delineated below, which have the potential for off-site as well as on-site impacts, offer opportunities as described:

- A ClF_3 release or F_2 release from fire/explosion due to use of incompatible materials; an HF release from cylinder puncture; a PCB release due to fire in a transformer or capacitator.

  Because preventive measures are engineering specifications and procedures, examination of these controls for possible improvement and reviews of applications of specifications/procedures offer the potential for further risk reduction. additionally, since Emergency response is currently the most effective form of mitigation for the release of any toxic gas, further study of the training/procedures/public notification in this area could improve overall safety.

- A UF_6 release resulting from a lube oil system fire/ventilation ducting fire in a process building.

  Opportunities for additional risk reduction in these areas may be identified in the studies to be conducted by Factory Mutual. Factory Mutual is assessing the plant from the perspective of a fire insurance underwriter and is evaluating the fire risk in both the lube oil system and the ventilation ducting.

- A UF_6 release from crane failure in a process building.

  Opportunities for improvement in this area involve examination of the relevant maintenance and operations procedures and administrative controls for ways to strengthen both preventive and mitigative measures.

- A UF_6 release from a cylinder drop and puncture, LEU and Tails Withdrawal Facility or LEU Sampling and Transfer Facility.

  There are activities and studies underway aimed at improving the safety of the lifting, moving, and overall handling of cylinders. The ongoing multi-site UF_6 Cylinder

Handling Committee is one such activity that makes recommendations with respect to safety improvements. Additionally, a formal PRA is being conducted for PORTS by SAROS, who will evaluate the risks of cylinder-handling operations. The PORTS report from SAROS was due in March 1990.

- A UF_6 release from explosion due to hydrocarbons in product or tails cylinders.

  Opportunities for further study in this area involve work with vendors to improve their quality assurance and eliminate sources of oil inleakage and work in-house to improve/increase inspections of cylinders.

Other Class B Risk conditions exist with the potential for on-site impact only. These hazardous conditions, which include PCB contamination, radiation exposure, and R-114 release, also offer opportunities for effective risk reduction and merit subsequent studies.

In addition, Class C Risk conditions, i.e., those which pose no serious risks but which should be incorporated into improvement planning, were identified. These include such conditions as lube oil system fires and UF_6 release due to B-line block valve closure.

The hazards analyses and resulting risk evaluations summarized above characterize the conditions that support continued operation of PORTS.

7. Y-12 PLANT CONTINUED OPERATIONS EVALUATION

7.1 IMPLEMENTATION OF METHODOLOGY AT THE Y-12 PLANT

The PSET at Y-12 was led by the Plant Manager and the DOE Site Representative at Y-12. The PSET determined the facilities to be evaluated in the Phase 0 Continued Operations Evaluation.

An FSET was appointed for each of the 14 facilities selected at Y-12. These teams followed the methodology as previously described in Section 2. The results of the FSET evaluation were presented to the PSET which reviewed the evaluations for thoroughness, accuracy, and existence of supporting documentation.

The facilities chosen for evaluation were considered to involve the greatest potential risk of death or serious injury to workers or the public.

1. Alpha-5 Arc Melt Facility
2. Building 9720-5, Nuclear Material Safeguarded Shipping and Storage
3. Building 9204-4, Quality Evaluation Laboratory and retirement/Reclamation Area
4. Building 9215, O-Wing Rolling and Forming
5. Building 9204-2/2E, Assembly Operations
6. Building 9206
7. Building 9212, Enriched uranium Recovery and special Processing Operations
8. Buildings 9805-1 and 9805, Deuterium Manufacture
9. Building 9204-2, Lithium Chemistry Facility
10. Building 9212, E-Wing Casting
11. Buildings 9215 and 9998, M-Wing Machining
12. Hydrogen Fluoride Acquisition, Distribution, and Storage
13. Building 9401-5, Uranium Chip Oxidation Facility
14. Delta Barriers

7.2 RESULTS OF THE Y-12 PLANT EVALUATIONS

The results of the Y-12 Plant evaluations are given in Table 7.1 which summarizes the risk classifications for the various scenarios for each facility. The final results of these evaluations, as approved by the PSET, are summarized as follows:

- One scenario, the rupture of a caustic (electrolyte) line during a transfer operation, received an "A" rating. Procedures to improve the rating to a "B" were put in place before plant personnel resumed the handling and transferring of caustic electrolyte.

- One other activity, the shipment of HF over public highways, has been suspended even though it did not receive an "A" rating. Such shipments will be resumed only after documentation of design and testing adequacy of the shipping containers has been assured.

- For the 111 scenarios with a "B" rating, approximately 100 recommendations for improvement have been identified, and these will be further evaluated and/or implemented as appropriate.

- The remaining 168 scenarios received a "C" rating.

Table 7.1. Results of Y-12 Plant Evaluation by Risk Classification

Facility	Number of Scenarios			
	Class A	Class B	Class C	Total
Alpha-5, Arc Melt Facility	0	1	5	6
Building 9720-5, Nuclear Material Safeguarded Shipping and Storage	0	4	15	19
Building 9204-4, Quality Evaluation Laboratory and Retirement/ Reclamation Area	0	3	6	9
Building 9215, O-Wing Rolling and Forming	0	10	13	23
Building 9204-2/2E, Assembly Operations	0	1	21	22
Building 9206	0	4	7	11
Building 9212, Enriched Uranium Recovery and Special Processing Operations	0	71	19	90
Buildings 9805-1 and 9805, Deuterium Manufacture	1	4	9	14
Building 9204-2, Lithium Chemistry Facility	0	5	6	11
Building 9212, E-Wing Casting	0	3	24	27
Buildings 9215 and 9998, M-Wing Machining	0	0	19	19
Hydrogen Fluoride Acquisition, Distribution and Storage	0	1	5	6
Building 9401-5, Uranium Chip Oxidation Facility	0	4	18	22
Delta Barriers	0	0	1	1
Total	1	111	168	280

8. CONCLUSIONS

The Phase 0 Continued Operations Evaluations evaluated formally 538 scenarios and considered many others that were not sufficiently significant to warrant further analysis. Three of the scenarios were classified as Class A risk, and actions were taken immediately to suspend operations or to reduce the risk to an acceptable level (Class B or less). Of the remaining scenarios, 172 were classified as Class B risk, and 363 were classified as Class C risk.

Corrective actions either have been identified or are being identified to reduce the risk of Class B scenarios where it is possible to do so and to take the opportunity for improvements for Class C scenarios if it appears cost effective to do so.

References

1. H. T. Conner, Jr., *Continued Operations (Phase 0) Evaluation of the K-25 Site*, K/C-xxxx-DF (December 1989).

2. *Oak Ridge National Laboratory - Phase 0 - Plant Safety Evaluation Summary* (Dec. 18, 1989).

3. T. A. Angelelli, R. B. Schappel, J. Dykstra, A. L. Lotts, J. E. Trainer, *Paducah Gaseous Diffusion Plant Continued Operation Hazard Analysis/Risk Evaluation*, KY-783 (Dec. 1, 1989).

4. T. A. Angelelli, R. B. Schappel, J. Dykstra, J. E. Trainer, *Portsmouth Gaseous Diffusion Plant Continued Operation Hazards Analysis/Risk Evaluation*, POEF-2020 (Dec. 15, 1989).